Evaluation of Frequency of Use by Orangutans of Structures and Locations within a Captive Environment

Linda McGuire-Rook

Abstract

An orangutan exhibit at the Sedgwick County Zoo is studied for the purpose of examining the social behavior of orangutans in a captive environment. Specific reference is made to the patterns of use of various movable and immovable structures and specific locations displayed by the occupants of the exhibit. Patterns of individual preferences and utilization of the exhibit are also discussed, illustrating the spatial and structural needs of individual orangutans. The results are hoped to further our understanding of the need for improved facilities for captive orangutans as social groups and as individuals.

Acknowledgements

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Background

Two essential characteristics of the orangutan include their primarily arboreal behavior, and a demonstrated capacity for the use of tools. Observed in the wild, both traits appear to reflect a general level of intelligence or cognitive structure (Jolly 1985). In captivity, the orangutans arboreality and their possession of individual levels of cognition, may be identified through studies of the selective use of structures or locations by individual orangutans. In order to address the mental and physical needs of the captive orangutan it is therefore imperative that patterns of group behavior and
individual preference for various structural components of an exhibit be considered in the design or redesign of captive orangutan facilities. Ideally, captive environments should provide arboreal space, represented by either natural or artificial arboreal structures, terrestrial space, and other vertical and horizontal structural components. In existing exhibits where such space is not available, a more natural environment may be achieved through redesign. However, to do so requires knowledge of individual orangutan habits and preferences regarding the structures and areas in the existing exhibit. Yet space is not the total answer to a viable ape exhibit. The exhibit must include structures which enhance the quality of the space (Wilson 1982).

Orangutan intelligence, the meaning, matter, and degree of which is relative and for the most part not well understood, is documented regarding tool use and nest-building (Lethmate, 1977 cited in Lethmate 1982; Galdikus 1982; Rijksen 1978; Maple 1980). Jolly (1985) refers to tool use as the means to measure cognitive structure or general intelligence. Tool use among orangutans suggests the presence of cognitive structures within the brain, similar to though less complex than observed among humans (Beck 1980). Galdikus (1982) suggests that orangutan nest-building may reflect inherent manipulative capabilities, supporting earlier hypotheses speculating that nest-building is learned and skills for nest-building are accumulated over time during critical periods in an orangutans' adolescence (Bernstein 1969 cited in Tuttle 1986). However, tool use and nest-building skills have not been observed in rehabilitated adolescents when released into the wild (Rikjsen 1978).
In the early part of the eighteenth century, Daniel Beeckman became one of the first westerners to purchase a live orangutan. Even though the captive orangutan remained alive for nearly seven months, it was never discerned whether it was capable of being trained (Harrison 1962). From Beeckman’s 1880’s purchase until the middle of the 20th century, orangutans were kept in captive environments more as novelties of nature and members of collections. During this period, orangutans were rarely housed in environments consistent with their needs as a species or as individuals (Maple 1980). Research into their natural behavior and more importantly their captive behavior was virtually non-existent until the middle of the 20th century. However, research in these areas is needed to better define the potential of the cognitive abilities of the orangutan.

Whenever a captive environment provides the opportunity, behavioral patterns of captive orangutans appear to correspond to general patterns of behavior of wild orangutans. Yet captive orangutans also show patterns of social behavior unobserved in the wild. Captive environments force orangutans to redirect their capacity for intelligence, otherwise measured through wild behavior such as tool use and nest-building. In the wild the great apes differ with regard to curiosity and emotions (Maple 1980) and they exhibit individualistic skills of tool use and nest-building (Rikjsen 1978; Galdikus 1982). In captivity, tool use, nest-building and use of structures continue to be individualistic. Accordingly, captive conditions should reflect the natural habitat of the orangutan, requiring designers of captive environments to
recognize a need for sufficient structures to provide the individual preferences observed in captive orangutans.

Materials & Methods

The subjects of study include five orangutans housed at the Sedgwick County Zoo, Wichita, Kansas. The group consists of one adult male, two adult females, a juvenile female and male (Table 1). The orangutans are maintained in a fully enclosed habitat within a climate controlled building and have full access to a day enclosure from approximately 8:30 in the morning until 4:30 in the afternoon. The orangutans spend the remainder of the time in the night cages where they are fed twice daily.

<table>
<thead>
<tr>
<th>Name</th>
<th>Group</th>
<th>Gender</th>
<th>Date of Birth</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toean</td>
<td>Sumatran</td>
<td>Male</td>
<td>Jan. 2, 1973</td>
<td>Captive</td>
</tr>
<tr>
<td>Tia</td>
<td>Sumatran</td>
<td>Female</td>
<td>Jan. 30, 1957</td>
<td>Wild</td>
</tr>
<tr>
<td>Blanda</td>
<td>Sumatran</td>
<td>Female</td>
<td>Jun. 26, 1964</td>
<td>Wild</td>
</tr>
<tr>
<td>Sayang</td>
<td>Sumatran</td>
<td>Female</td>
<td>Nov. 21, 1983</td>
<td>Captive</td>
</tr>
<tr>
<td>Sabah</td>
<td>Sumatran/Bornean hybrid</td>
<td>Male</td>
<td>Mar. 6, 1985</td>
<td>Captive</td>
</tr>
</tbody>
</table>

The exhibit is a large indoor enclosure of approximately 1,455 square feet. One side of the exhibit is an observation wall partitioned into eight glass panes (Figure 1). Each pane consists of three inch thick safety glass. The opposite wall of the exhibit consists of wire mesh fencing separating the enclosure from an area of foliage and the
outside of the building (Figure 1). The outside wall contains large windows that can be opened for ventilation. On one end the exhibit consists of a solid concrete wall, on the other end the exhibit is composed of enclosures which function as night cages. The night cages are separated from the day enclosure by sliding doors containing windows constructed of the same type of safety glass used on the observation wall (Figure 1). Two windows located on the outside wall above the night cages and six skylights in the ceiling are covered with wire mesh, and can be opened for ventilation (Figure 1). The day enclosure includes a climbing structure of log scaffolding comprising vertical and horizontal poles. The structure forms the support for 3 raised platforms of different heights. Also present is a stationary horizontal ladder, a drinking pool and two large piles of boulders. The only movable structure in this enclosure is a hammock-like swing made from fire hose (Fig. 1.).

Thirty-nine loci were defined for recording purposes and labeled on the floor plan including three platforms (A, B, and C), in addition to other structures and general areas of the exhibit (1 - 36). A detailed description of the individual structural components and areal of the exhibit locations defined in the present study is provided in table 2. Observations of the location of each orangutan, including the name and position of an individual was logged at 15 minute intervals on a floor plan of the exhibit. Observations were repeated at different times during the morning and afternoon. Time of day, outside weather condition, skylight and window status (open vs. closed), and number of visitors at the exhibit were recorded on each day of observation. A total of 33 hours and 15 minutes of observation, gathered during the
period from January 21, 1991 to March 5, 1991, represent the observational frame of reference for the present study.

Table 2 - Description of structures and area loci.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Highest platform in exhibit.</td>
<td>16</td>
<td>Skylight.</td>
</tr>
<tr>
<td>B</td>
<td>Lower platform.</td>
<td>17</td>
<td>Skylight.</td>
</tr>
<tr>
<td>C</td>
<td>Lower platform.</td>
<td>18</td>
<td>Skylight.</td>
</tr>
<tr>
<td>I</td>
<td>Floor area inside exhibit in front of entrance to day enclosure.</td>
<td>19</td>
<td>Skylight.</td>
</tr>
<tr>
<td>1a</td>
<td>Area above entrance to day enclosure.</td>
<td>20</td>
<td>Skylight.</td>
</tr>
<tr>
<td>2</td>
<td>Sliding door entrance to night cages</td>
<td>21</td>
<td>Wire grate in ceiling.</td>
</tr>
<tr>
<td>3</td>
<td>Sliding door entrance to night cages.</td>
<td>22</td>
<td>Hole dug in floor of enclosure.</td>
</tr>
<tr>
<td>4</td>
<td>Area above observation window.</td>
<td>23</td>
<td>Floor area between west-end of exhibit and log scaffolding.</td>
</tr>
<tr>
<td>5</td>
<td>Boulder Pile</td>
<td>24</td>
<td>Low locus on wire mesh fence.</td>
</tr>
<tr>
<td>5a</td>
<td>Floor area between boulder pile and platform B.</td>
<td>25</td>
<td>Low locus on wire mesh fence.</td>
</tr>
<tr>
<td>5b</td>
<td>Floor area underneath horizontal ladder.</td>
<td>26</td>
<td>Middle locus on wire mesh fence.</td>
</tr>
<tr>
<td>6</td>
<td>Boulder pile.</td>
<td>27</td>
<td>Floor area at bottom of vertical scaffolding pole.</td>
</tr>
<tr>
<td>7</td>
<td>Top of vertical scaffolding pole.</td>
<td>28</td>
<td>Floor area at bottom of platform A</td>
</tr>
<tr>
<td>8</td>
<td>Top of vertical scaffolding pole.</td>
<td>29</td>
<td>High locus on wire mesh fence.</td>
</tr>
<tr>
<td>9</td>
<td>Horizontal scaffolding</td>
<td>30</td>
<td>High locus on wire mesh fence.</td>
</tr>
<tr>
<td>9a</td>
<td>Horizontal scaffolding</td>
<td>31</td>
<td>High locus on wire mesh fence.</td>
</tr>
<tr>
<td>9b</td>
<td>Horizontal scaffolding</td>
<td>32</td>
<td>Floor area at bottom of vertical scaffolding pole.</td>
</tr>
<tr>
<td>10</td>
<td>Top of vertical scaffolding</td>
<td>33</td>
<td>Floor area in corner of exhibit between entrance to day enclosure and sliding door.</td>
</tr>
<tr>
<td>10a</td>
<td>Horizontal ladder.</td>
<td>33a</td>
<td>Window to outside.</td>
</tr>
<tr>
<td>11</td>
<td>Horizontal ladder.</td>
<td>33b</td>
<td>Window to outside.</td>
</tr>
<tr>
<td>11a</td>
<td>Top of vertical scaffolding pole.</td>
<td>34</td>
<td>Floor area in corner of exhibit between entrance to day enclosure and wire mesh fence.</td>
</tr>
<tr>
<td>12</td>
<td>Water pool.</td>
<td>35</td>
<td>Top of vertical scaffolding pole.</td>
</tr>
<tr>
<td>12a</td>
<td>Floor area next to wire mesh fence.</td>
<td>36</td>
<td>Floor area at bottom of platform.</td>
</tr>
<tr>
<td>13</td>
<td>&quot;Harrmock&quot; fire hose swing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13a</td>
<td>Floor area underneath &quot;harrmock&quot;.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results

Patterns of use of structures and areas in the captive exhibit illustrates that the highest of the three platforms (A) is used more frequently than any other structure or location in the exhibit. Relatively high frequencies of use of two other arboreal locations (8 and 10) is also observed (Figure 2). In general, preference for the higher platform is shared evenly among four orangutans, while Blanda, the second oldest female of the group, shows considerably less preference for the higher platform (A)
(Figure 2). The two lower platforms see much less activity, but when in use, they are occupied primarily by Sabah, the young male, Sayang, the youngest female, and Blanda.

Floor areas are somewhat evenly occupied by all orangutans, although Toean, the adult male, favors the areas by the sliding door entrance to the night cages (area 3), beneath the higher platform (area 28), and to a lesser extent the boulder pile (area 6) (Figure 2). Blanda, the second oldest female shows preference for the area underneath the hammock-like fire hose swing (area 13a), while Tia, the older female, spreads herself among floor areas at the base of the vertical scaffolding pole (area 27), and the corner of the exhibit between the entrance to the exhibit and the sliding door to the night cages (area 33) (Figure 2). Sabah, the young male, and Sayang the youngest female, share an interest in the hole dug in the floor of the exhibit (area 22), the floor area between the west-end of the exhibit and the log scaffolding (area 23), and the area beneath the higher of the platforms (area 28) (Figure 2).

Activity on the wire mesh fence, especially on the lower part (areas 24 and 25), is relatively frequent for all members of the group (Figure 2). The orangutans were observed at these locations, particularly when there was activity by the zookeepers in the area between the wire mesh fencing and the outside wall of the exhibit. Sayang, the youngest female commonly positioned herself on the wall, immediately above the observation window (area 4), and atop the vertical scaffolding poles (areas 7 and 8) (Figure 2). Tia, the older female frequents the vertical scaffolding poles (area 10) (Figure 2). Sabah, the young male, is almost the sole user of the hammock-like
Figure 2. Patterns of use and activity - general exhibit
STRUCTURES AND LOCATIONS

Figure 2. Continued
Figure 2. Continued.
fire hose swing (area 13), but shares with Sayang in the use of the skylights (area 10), from which they frequently hang (Figure 2).

A more detailed illustration of the activities of Toean, the adult male, and his use of the structures and locations in the exhibit is provided in figure 3. Except for his presence on the scaffolding (area 11a), or when brachiating along the horizontal ladder from the higher platform (A) to the boulder pile (area 6), Toean spent the remainder of his time on the ground foraging (Figure 3). His presence on the wire mesh fence was restricted to times when the zoo keepers were present. Toean's apparent preference for the sliding door leading to the night cages may be related to the window in the sliding door which allows him to look through to the night cages and beyond to the keepers' office area. From there, he usually watched the keepers clean the night cages as well as observe when food is served, signaling his access into the night cage. Unlike Blanda, whose preference for location 4 above the observation windows allows her to view any visitors, Toean seems totally uninterested in visitors. When he occasionally left his favorite spot at the sliding door location (area 3) to go to another area of the enclosure, he would raise his arm and drag it across the observation window.

At various times the adult male was joined on the higher platform (A) by the adult females, the juvenile female, and the juvenile male forming what could be perceived of as a social group (Figure 4). Sayang, the juvenile female, groomed Toean when she joined him on this platform. Tia, the oldest adult female was observed just sitting on the platform with Toean. Sabah, the juvenile male, used his association with Toean
Figure 3. Use and activity by Toean, the older adult male.
Figure 4. General platform use.
on the platform for various activities (Figure 4). His interaction with Toean was always one of action. Sabah was observed examining Toean's hands and mouth for content, sometimes pulling Toean's hair until the older male turned towards him so he could see. At times, Sabah acted as Toean's source for having a drink of water. While Toean remained sitting on the platform, Sabah would descend the platform, go to the water pool, fill his mouth with water, return to the platform and stand in front of Toean. The older male, in a sitting position, would lift his head and open his mouth. Sabah then opened his mouth and allowed the water in his mouth to run out and down into Toean's mouth.

The end of the log scaffolding above the higher platform (area 10), is a preferred location of Tia, the older female (Figure 5). She takes up position in this area each morning after leaving her night cage. Her usual activity at this location is sitting, facing the windows that form the outside of the building. Areas high on the scaffolding also provide Tia with the same type of sitting area as location 10. At these locations, Tia was observed sitting, holding or manipulating pieces of feed sacks or cardboard boxes. Her appearance on one of the lower platforms (B) occurred only when Sabah, her son was present on this platform (Figure 5). In one instance, she was observed lying on the platform, while Sabah sat on the platform manipulating straw and pieces of feed sack.

Directly below the wire mesh opposite the window, the orangutans have dug a large hole in the sand and dirt mixture of the enclosure floor where they forage for sunflower seeds and peanuts. Although she was never observed foraging around the
Figure 5. Use and activity by Tia, the older female.
hole, Tia would dangle on the fence above when other orangutans were foraging. Tia also occupied the wire mesh fence, when a keeper was nearby.

Blanda, the youngest adult female displayed notably less use of the higher platform (A) than observed among the other four orangutans in this group (Figure 6). She frequently assumed a dangling position over an area above the observation window (area 4) when zoo visitors appeared at the window and remained hanging upside down for long periods of time (Figure 6). Her appearances on the wire mesh fence at areas 25, 26, 30, 31, and 34, may be examples of her curiosity about any activity in and about the exhibit. On occasion, Blanda and the juvenile male, Sabah, engaged in mating activity above the observation window (area 4) (Figure 6). The mating activity began with observed hand to mouth contact (including biting) then mouth to mouth contact (including biting), followed by copulation. Blanda and her daughter Sayang were also observed sitting and sleeping together on the scaffolding at areas 8 and 9a on several occasions (Figure 6).

Sayang, the juvenile female, uses all the structures and areas of the day enclosure more regularly than the adult members of the group. Her observed activity on the higher platform (A) included repeated grooming of Toean, even in her mother's presence (Figure 7). Her presence at locations 3, 3a, 33b, and 4, are all areas close to area 3, an area preferred by Toean. She was observed in these areas when Toean was present at area 3. Area 2 opens into Sayang's night cage and she was frequently observed to sit in this area apparently looking through the window, as well as at
FiguY'ë G. Use and activity by Bàanda, the second oldest female.
Figure 7. Use and activity by Sayang, the youngest female.
several higher loci (Area 9, 10a, and 11b) where she would be covering her head with pieces of feed sacks, and cardboard boxes (Figure 7).

Together, Sayang and Sabah, the juvenile male, used the higher platform (A) as a base for playing (Figure 7). Play included wrestling and grabbing pieces of torn feed sacks and cardboard boxes from one another. However, Sayang’s presence on the lower platforms (8) and (e) also involved attempts at nest-building, using hay, cardboard boxes, and paper feed sacks (Figure 7). Sayang was sometimes observed brachiating from the wire grates, even approaching the observation windows at various locations when small children were standing on the bench in front of the windows.

Except for the higher platform (A) and the location above the observation window (area 4), Sabah, the juvenile male, uses more structures and locations in the exhibit than any other orangutan in the group. Sabah was frequently observed interacting with Toean on the higher platform (A) seeking to get Toean to react to his presence (Figure 8). As Sabah approached or touched the platform during Sayang’s presence, the young female immediately left the platform. As long as he remained on the platform with any of the other orangutans, she would not return. Only when the others left, would she return to the platform to join Sabah in play.

Sabah was observed sitting near Toean, directly between the older male and the sliding door to the night cages. Sometimes the young male would climb onto Toean’s head or shoulders while the older male was facing the window in the sliding door (Figure 8). During this time, Sabah repeatedly sought to engage Toean in play.
Figure 8. Use and activity by Sabah, the younger male.
Discussion

The findings of the present study of captive orangutan behavior pertaining to the use and occupation of structures and specific locations shows a distinct preference for those structures which most resemble the natural habitat of the wild orangutan. The frequent use of the higher platform (A) among the captive orangutans, reflects the primarily arboreal preferences of their counterparts in the wild. The adult male and females show individual preferences for specific structures and areas in the captive environment. Individual preference for specific structures and areas is less significant in juveniles. Greater use of structures and areas by individual orangutans may also correspond to the age of individual orangutans. The three adult orangutans all occupied fewer structures and areas less regularly than did the two juveniles.

Toean’s preference for platform (A) is a restatement of the primarily arboreal quality of the life of orangutans in the wild. The artificial arboreal location presented by the captive environment serves as a stage for perceived social interactions between Toean and the other members of this group. The orangutans’ grouping behaviors in this captive environment are undocumented in the natural wild environment. In the natural environment adult males exhibit solitary qualities (MacKinnon 1978; Jolly 1985; Maple 1980). The boulder pile (area 6) seems to provide the adult male with an area where he can conceal himself from the observation windows. He was observed sitting hunched down or lying behind these boulders peering out between the boulders in the direction of the observation windows. This is the only location in the day enclosure that enables Toean to be concealed. This
behavior may be linked to the observed solitary behavior of orangutans. In a natural environment he could conceal himself in dense foliage of the forest's upper canopy.

Tia, the older female could possibly be considered the dominant female of the group based on her frequent appearance on the higher platform (A). Considering orangutan matriarchy and lack of female bonding, Tia appears to be an important member of the apparent social group of orangutans frequenting this platform. Other important members of this group include the adult male, the juvenile female and male. Blanda's limited use of the platform seems to suggest that her role in the group is less easily defined. Tia's preference for the higher platform (A) serves as the base for her nest-building and sleeping activity. Nest building is carried out using cardboard boxes, hay, and large paper feed sacks, and may represent a continuation of observed wild behavior using tree leaves and branches for nest-building material. She was observed sitting on this platform with a large piece of feed sack or piece of cardboard box covering her head, a behavioral pattern which may correspond to observed behavior among wild orangutans where they attempt to cover themselves with large leaves to deflect rain. Her secondary use of other locations in the compound may be a reflection of her age and/or a lack of need or incentive to forage for food. In a wild environment, Tia's days would be filled with foraging and resting (Zucker et al. 1986).

Juvenile males in their natural environment play more actively, cover a wider territory, and use more natural variables than their female counterparts (Jolly 1985). Sabah, the juvenile male in this study, parallels this activity in the captive environment. His presence on the higher platform (A) may be considered as a juvenile
need to be near his mother, Tia, and as juvenile sociability in playing with Sayang. Both types of behavior are documented in the wild. Sabah's observed close association with the adult male represents an association undocumented in natural environments. In the natural environment, the adult male is perceived as solitary and juvenile males of Sabah's age have not been observed in this proximity to the adult male.

In the present study, weather conditions did not appear to have an effect on the use of specific structures or areas. When the skylights were open and outside air entered the enclosure, the open skylights were investigated by the orangutans on an individual basis. The skylights were not necessarily investigated every time they were open. The effect visitors have on this group of orangutans remain unanswered. The adult male's use of one boulder pile may relate to visitors presence just as the second oldest female's use of an area above an observation window may have increased when the public was present.

Everything on this planet matters and in agreement with Calvin Martin (1978) life on this planet must exist in reciprocity and in relationships of courtesy. Humans have long disregarded the cognitive capacity of orangutans, and without restraint, we have captured, and relocated apes such as the orangutan in captive environments with little or no regard to nature of their habitat needs. This study shows an unquestionably individualistic preference for specific structures and loci which reflects a combination of inherent wild behavior, sex, age, and social position within the captive group. With this in mind, our attitude toward orangutans in the wild must change before total
extinction occurs. Simultaneously, this relationship and attitude must change regarding captive environments. Captive orangutans differ from their wild counterparts most notably in the formation of social groups not dependent on diet and habitat. Social groups of this type are undocumented in the wild. This grouping behavior requires captive environment changes previously not considered.

An understanding of species preference for a specific habitat, such as the primarily arboreal environment of the orangutans, and the individual orangutan's preference for a specific location or area in within this environment, is paramount to the design or redesign of a captive orangutan exhibit. Change inevitably affects the individual, and as preferences for structural locations and areas may change and so may individual behavior. Orangutans require extensive space in natural and captive environments. When space is restricted and a natural environment has not been approximated, redesign of an exhibit necessitates an understanding of individual orangutan habits and preferences regarding the structures and areas to be placed in the exhibit. The present study identifies some areas of the the present exhibit as unused, and suggests that such unused structures or areas should perhaps be redesigned with reference to individual orangutan preference. The design and construction of an orangutan habitat sturdy enough to withstand the species' strength is a major challenge. Practical consideration including cost of material and labor can be aided or controlled if previous knowledge of effective and ineffective structures and areas are available. This knowledge must be applied to structure and area use regarding the species and well as the individual orangutan. If orangutans are to be continually preserved in captive
as the individual orangutan. If orangutans are to be continually preserved in captive artificial or pseudo-natural environments, then we must engender respect for them as individuals. The intelligence of orangutans can be affected by the nature of the environment (Maple 1980). If the intelligence of an orangutan can be affected by his present environment then an orangutan is intelligent enough to be affected by changes in his environment. As the conservation of orangutans continues, a more natural habitat must be provided and our knowledge of orangutans as individuals must continue.

References Cited

- Beck, B.  
  New York: Garland, STM Press.

- Galdikas, B.M.F.  
  1982, Orang-utan tool-use at Tanjung Puting Reserve, Central Indonesian Borneo (Kalimantan Tengah).  

- Harrison, B.  
  1962, Orang-utan.  
  London: Collins.

- Jolly, A.  

- Lethmate, J.  
  1982, Tool-using skills of orang-utans.  
-MacKinnon, J.

-Maple, T.
  New York: Van Nostrand-Reinhold.

-Maple, T. and W.R. Stine
  1982, Environmental variables and great ape husbandry.

-Martin, C.

-Rijksen, H.D.
  1978, A field study on Sumatran orangutans (Pongo pygmaeus abelii Lesson 1827).
  Netherlands: H. Veenman and Zone, B.V.

-Tuttle, R.H.
  New Jersey: Noyes Publications.

-Wilson, S.F.
  1982, Environmental influences on the activity of captive apes.
  *Zoo Biologica.* Volume 1:201-209.

  1986, Play profiles of captive adult orangutans: A developmental perspective.